Regional difference of Lg wave propagation in Japan derived from dense seismometer network: Southwestern and Northeastern Japan

Masahiro Kobayasjhi[1]; Takashi Furumura[2]; Tatsuhiko Saito[2]; Shunsuke Takemura[1]

[1] ERI, Univ. Tokyo; [2] CIDIR, Univ. Tokyo

1. Introduction

Lg phase is clearly recognized in the seismic waves propagating through continental crust, which is characterized by a dominant frequency component around 0.5 - 5.0 Hz and a group velocity of 3.5km/s. The Lg phase is considered as a superposition of multiple post-critical reflection of S-wave in the crust (e.g. SmS). Since the Lg amplitude decreases with the travel distance more slowly than a direct S-wave, the Lg phase can propagate longer distance more than a few hundred km. The Lg propagation in continental crust such as in the United States and in Europe has been studied by numerous seismologists [e.g. Xie et al., 1990,Singh, 2007]. In Japan, however, since the studies done by Utsu (1958) and Shima (1962), a few studies have been done in characterizing Lg phase propagation [e.g. Furumura and Kennett, 2001].

In order to quantify the regional difference of the Lg phase around Japan and investigate the relation between characteristics of Lg phase and the crustal heterogeneities, we analyze a large number of seismograms recorded by high sensitivity seismograph network Japan (Hi-net). We then compare the features in each region, such as the Southwest Japan, the Pacific Ocean side of Northeastern Japan (Fore-arc side) and the Japan Sea side of Northeastern Japan (Back-arc side).

2. Difference of observed Lg phase between Southwest Japan and Northeastern Japan

We analyzed 750 seismograms of an event (Mw 4.1, depth h = 21.4 km) occurring in the center of Japan (eastern part of Yamanashi pref.) on July 15, 2008. We found clear regional differences in the Lg phase among the three regions.

(A) Southwestern Japan: (1) clear wave packets of SmS phase are recognized. (2) The envelope of the Lg phase shows a spindle shape, indicating smoothly increasing amplitude around the onset and smoothly decaying coda amplitude. (3) The Fourier spectrum of the Lg phase has a peak around 1.5 Hz, and the spectrum of Lg phase rapidly decays in the high-frequency range above 2 Hz (4) The group velocity of Lg phase is 3.50km/s and it is easily distinguished from Sn arrivals (4.27km/s).

(B) Fore-arc side in Tohoku: (1) clear wave packets of SmS phase are recognized. (2) The envelope shape indicates a sharp increase at the onset (3) The Fourier spectrum has a peak around 3 Hz and decays more slowly than in the Southwestern Japan in the high frequency range above 2 Hz. (4) The group velocity is 3.58km/s and it is difficult to distinguish the Lg phase from Sn arrivals.

(C) Back-arc side in Tohoku: (1) It is difficult to recognize clear SmS phase. (2) The amplitude of the whole envelope including direct and late coda is small, especially in the high frequency range above 2 Hz. (3) The Fourier spectrum has a peak around 1.5 Hz but the spectrum rapidly decays in the high-frequency range above 2 Hz. (4) The group velocity is 3.50 km/s, which is almost the same as in Southwestern Japan, but slower than in the fore-arc side.

Shima (1962) noted a clear difference of the group velocity of Lg phase between southwestern Japan (3.44 km/s) and northeastern Japan (3.57 km/s). The group velocities obtained in this study agrees with Shima's study. However, we found a clearly difference of group velocity between the fore-arc and the back-arc sides of Northeastern Japan. This difference between the fore-arc and the back-arc sides reflects the difference in S-wave velocity structures. The variation of Moho depth and the thickness of the sedimentary layer can also significantly affect Lg propagation [e.g. Li et al, 2007].

In order to figure out what causes those clear regional differences in the Lg phase, it is important to estimate the heterogeneous crustal structure, to simulate the Lg phase propagation in a model, and to compare them with the observed seismic field.